gonal lattice[10] while the calculated T_C-Q relation is for the cubic lattice. However in view of the small effects[1,10,11] of the lattice transformation on the electronic properties of Nb_3Sn and V_3Si, we believe that the general T_C-Q behavior for the tetragonal lattice is similar.

Recently the temperature dependence of the pressure coefficient of the shear modulus of V_3Si was observed[13] to decrease from a positive value to a negative minimum before reversing the sign back to positive at lower temperature. To explain this anomalous behavior and the negative dT_L/dP of V_3Si, it was proposed[4,14] that the WLF model should be extended to include effects due to the pressure-induced interband charge transfer. By fitting the experimental data, Ting and Ganguly and Barsch and Rogowski found[4] that pressure indeed enhances Q. Using Ting and Ganguly's estimate, we found that at 20 kbar Q increases by ~10% but still lies below Q_{CM}, in agreement with the observation of positive dT_C/dP at this pressure.[15] According to this model, a pressure of ≥ 34 kbar is needed to raise Q to above Q_{CM} such that dT_C/dP changes to negative sign. Earlier it[4] was determined through extrapolation that ~ 24 kbar is sufficient to stabilize the cubic lattice in V_3Si, suggesting that $Q_0 < Q_{CM}$, consistent with the recent observation of positive dT_C/dP for both the transforming and nontransforming V_3Si samples.[16] On the other hand, Labbé, Barišić, and Friedel[12] obtained $Q_0 > Q_{CM}$. This disagreement may be attributed to the uncertainties associated with the physical parameters used in their calculation. Lack of experimental data prevents us from making a similar comparison for Nb_3Sn. However a discussion of the experimental results at atmospheric pressure of doped Nb_3Sn in terms of the WLF model is worthwhile. For $Nb_3Sn_{1-x}Al_x$,[17] a slight replacement of Sn by Al results in a decrease of Q and hence a decrease of T_L but an increase of T_C, as was observed. With large x, e.g., ≥ 0.08, the lattice remains cubic below T_C, while T_C still increases. This absence of lattice transformation may arise from the higher density of imperfections in the crystal lattice, as for the case of V_3Si.[18] However for $Nb_3Sn_{1-x}Sb_x$,[19] the substitution of Sb for Sn not only increases Q but also changes the ratio c/a from <1 to >1. The ratio Q_{LM}/Q_{CM} may consequently shift from >1 to <1. The observed x-independent T_L and x-decreasing T_C are thus not unlikely. Studies of T_L and T_C of these samples under hydrostatic pressure, where presumably only Q variation is important, are planned to check the explanation of the doped-Nb_3Sn results, suggested above.

Recently Ting and Ganguly[14] calculated the isothermal pressure coefficient $(\partial C_s/\partial P)_T$ of the shear modulus C_s, on the basis of the WLF model. By extending their formalism and using their notation, we have obtained an expression for dT_L/dP. T_L is defined as the temperature[12] at which the shear modulus C_s vanishes, i.e.,

$$C_s(T_L) = 0 = \tfrac{1}{2}Na^2q^2\int_{-|E_0|}^{|E_0|} dE\, nE(f + E\partial f/\partial E) + C_s', \tag{1}$$

subject to the constraint

$$Q = \int_{-|E_0|}^{|E_0|} dE\, nf, \tag{2}$$

where $n = (4/\pi)[2|E_0|(|E_0|+E)]^{-1/2}$ is the density of states of the d sub-band; $f = [1+\exp(E-E_F)/kT_L]^{-1}$, the Fermi function at T_L with Fermi energy E_F; $3N$ is the number of transition metal atoms per unit volume; a is the interatomic distance, q the Slater coefficient of the atomic d orbital, $|E_0|$ the half-width of the d sub-band, and C_s' the temperature-independent part of C_s. Under pressure, with strain $\epsilon = \kappa P/3$, $N \to N(1+3\epsilon)$, $|E_0| \to |E_0|\exp(aq\epsilon)$, $a \to a(1-\epsilon)$, $T_L \to T_L + (\partial T_L/\partial\epsilon)\epsilon$, and $Q \to Q + \delta Q$. By keeping only the first-order terms of ϵ in the Taylor's expansion of Eq. (1), we have

$$\frac{\partial \ln T_L}{\partial P} = + \frac{\tfrac{1}{6}N\kappa a^2q^2\int_{-|E_0|}^{|E_0|} dE\, nE[(1+aq)f + (1+2aq)E\partial f/\partial E + (aqE - \partial E_F/\partial\epsilon)(\partial f/\partial E + E\partial^2 f/\partial E^2)] + \partial C_s'/\partial P}{\tfrac{1}{2}Na^2q^2\int_{-|E_0|}^{|E_0|} dE\, nE[(E-E_F)(\partial f/\partial E + E\partial^2 f/\partial E^2) + E\partial f/\partial E]}. \tag{3}$$

The term $\partial E_F/\partial\epsilon$ in Eq. (3) is determined by Eq. (2), allowing $Q \to Q + \delta Q$ under stress. It is interesting to note that the numerator can be identified with $(\partial C_s/\partial P)_{T_L}$[14] and the denominator with $-T_L(\partial C_s/\partial T)_P$ provided $\partial E_F/\partial T$ is negligibly small. Hence Eq. (3) is reduced to the familiar form $(\partial T_L/\partial P) = -(\partial C_s/\partial P)_{T_L}(\partial C_s/\partial T)_P^{-1}$ whose validity has been demonstrated for V_3Si.[14] Lack of information about $\partial C_s/\partial P$ for Nb_3Sn makes the determination of δQ and consequently of $\partial E_F/\partial\epsilon$ very difficult. No attempt is made at using Eq.

(3) for any numerical calculation of $\partial T_L/\partial P$ for Nb_3Sn. A similar calculation on dT_C/dP, including the interband charge-transfer effect, can be done.

In conclusion, we have observed for the first time pressure-enhanced lattice transformation in a high-T_C superconductor. The opposite pressure effects on T_L and T_C of Nb_3Sn and V_3Si can be explained in terms of the WLF model by taking into account the pressure-induced interband charge transfer. Previous atmospheric results on T_L and T_C of doped Nb_3Sn samples were discussed and an expression for dT_L/dP was also obtained.

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